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Granulator Selection

Gould, T.H.

August 2, 1999

U.S. Department of Energy

Lawrence
Livermore
National
Laboratory

DISCLAIMER

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FMD Program
Plutonium Immobilization Project

Lawrence Livermore National Laboratory

August 2, 1999
PIP 99-087LTR

Mr. William Danker, MD-3
Immobilization Project Manager
Office of Fissile Materials Disposition
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, DC 20585

Dear Mr. Danker:

Subject: Granulator Selection

I have reviewed the attached evaluation of granulation technologies by the granulator selection committee and fully concur with their recommendation to implement the tumbling granulation technique for the Immobilization Project. Successful implementation of this granulation system will be materially aided by technology acquisition from Cogema/Belgonucleaire in the areas of powder transfer, dust control, and remote quick disconnect systems. It is imperative that we immediately establish a technical exchange for this technology, beginning with a visit to Cogema and Belgonucleaire facilities by key members of our team in August. Both Cogema and Belgonucleaire are receptive to assisting us in this matter.

Sincerely yours,

Thomas H. Gould, Manager
Plutonium Immobilization Project

THG:kg

Attachment

cc: P. Maddux, WSRC
T. Rankin, WSRC
G. Armantrout, LLNL
L. MacLean, LLNL
DCC (2)

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Date: June 30, 1999

To: Tom Gould

From: Guy Armantrout
Tom Rankin
Paul Maddux

Subject: Granulator Recommendation

Recommendation

Following our detailed review of the granulation reports and additional conversations with process and development personnel, we have reached a consensus position regarding granulator selection. At this time, we recommend going forward with implementation of the tumbling granulator approach (GEMCO) based on our assessment of the tested granulation techniques using the established criteria.

The basis for this selection is summarized in the following sections, followed by our recommendations for proceeding with implementation of the tumbling granulation approach.

General Observations

All five granulation technologies produced granulated products that can be made into acceptable sintered pucks. A possible exception is the product from the fluidized bed granulator. This material has been more difficult to press into uniform pucks without subsequent cracking of the puck during the sintering cycle for the pucks in this series of tests. This problem may be an artifact of the conditions of the particular granulation demonstration run involved, but earlier results have also been mixed.

All granulators made acceptable granulated feed from the standpoint of transfer and press feeding, though the roller compactor and fluidized bed products were dustier than the rest. There was also differentiation among the granulators in the operational areas of: 1) potential for process upset, 2) plant implementation and operational complexity, and 3) maintenance concerns. These considerations will be discussed further in the next section.

Note that concerns also exist regarding the extension of the granulation processes to powders containing actinides. Only the method that involves tumbling and moisture addition has been tested with uranium, and in that instance, significant differences were found in the granulation behavior of the powders.

Granulator Comparisons

We documented our key impressions on an Excel spreadsheet after reviewing the granulation reports (attached). In this spreadsheet, our findings (+ or -) were entered into the principle selection criteria categories during our review and discussions, with the more important observations bolded and in red. A subsequent ranking of the various granulators against the established criteria was then made based on this spreadsheet, and a relative overall ranking established using previously established weighting factors. The figure at the end of our recommendations indicates the relative rankings of the tested granulations approaches, with lower numbers being better.

Overall, the GEMCO unit was felt to best satisfy the selection criteria. The GEMCO unit was judged to produce a consistent and dust-free product. The unit is relatively simple in design and operation, and should not be very difficult to implement for Pu applications (including the plant) subject to the implementation considerations discussed below. Process control and avoidance of upsets were considered to be relatively straightforward. In addition, this technique has been demonstrated with uranium (actinide) oxide successfully.

In considering the remaining techniques, we felt that each of them had at least one major area of concern, even though these same techniques were felt to also have some substantial advantages in certain areas. These four techniques and their related concerns were:

1. Roller Compactor: There is concern about the unit's complexity with respect implementation, operation, and maintenance. In addition, the product is dusty which is counter to one of the advantages of granulation. Should water ever become an issue with the other granulation approaches, however, we would need to reconsider the roller compactor option. Behavior with actinide oxide in the powder is unknown at this time.

2. Fluidized Bed: There is significant concern about the complexity of the filter and offgas system and the impact of these systems on plant operations and maintenance. In addition, mixed results with a number of the sintered pucks raised a red flag. There would be a relatively higher cost of implementing this option due to its size and complexity. Behavior with actinide oxide in the powder is unknown at this time.

3. Blade Granulator: The blade granulator was reverse-engineered and is still an R&D piece of equipment. Though very simple in operation, a plant unit would be relatively large. The relatively smaller amount of mechanical working of the powder is a detriment in distributing the liquid and forming granules. Any process upset that caused the formation of balls of wet product would be more difficult to correct. Behavior with actinide oxide in the powder is unknown at this time, but should be similar to the GEMCO unit.

4. Pin Tumbler: The pin tumbler is attractively small for its throughput capacity. However, it depends on the balance of powder feeding and liquid injection in a continuous process. Loss of powder or liquid control has a greater potential for process upset, which would make either mud or dust. Holdup is relatively high at this time, but may be reduced with further design. Behavior with actinide oxide in the powder is unknown at this time, but should be similar to the GEMCO unit.

Recommendations for Tumbling Granulator Implementation

The recommended tumbling granulators (such as the tested slant-cone GEMCO unit) require the reliable making and breaking of the input and output connections to the rotating tumbler vessel without dust leakage. In addition, clean out and maintenance of the granulator internal parts will be required (such as during mandatory accountability cycles), and the degree of difficulty of accomplishing this is not currently known from a plant standpoint. (Note: all granulators would have this clean out requirement and uncertainty.) In modifying this granulator for testing with Pu in the PuCTF and for subsequent plant design, we recommend the following actions:

1. Technical exchange with Cogema / Belgonucleaire

The ability to develop and implement an automated system for coupling and de-coupling the blender from the feed systems and product hoppers must be demonstrated. Such a system must include reliable valves on both the feed and product lines as well as the tumbling vessel. Such a system must effectively contain dust, allow efficient and complete powder transfer, not require operator hands-on actions, and be highly reliable.

Reliable technology for making and breaking connections between process vessels and feed systems without dust contamination of the glovebox environment is known to exist at both Cogema and Belgonucleaire. We believe that it is essential to visit these organizations with a focused purpose to discuss such systems in detail and to adapt as much of the technology and vendor sources as possible to our system. If we don't, we will spend substantial resources re-inventing the wheel with much less assurance of success than would be possible otherwise. Note that making and breaking connections is key not only for granulation, but for many other process operations in the Pu Immobilization plant as well.

2. Discussions with GEMCO and other blender / tumbler fabricators

Satisfactory designs for cleaning and maintaining the granulation system must be developed and demonstrated. The current system is not engineered for Pu glovebox applications. The technology solutions required include contamination control during cleaning and minimizing exposure during these operations.

The GEMCO blender used as part of the down select tests was originally purchased for blending rather than granulation. Further exploration of available technology for achieving such granulation based on the tumbling / fluid injection approach will be pursued with GEMCO and other possible vendors with the intent of identifying optimum designs for clean out and maintenance and the reliable making and breaking of transfer connections.

cc: Lee MacLean

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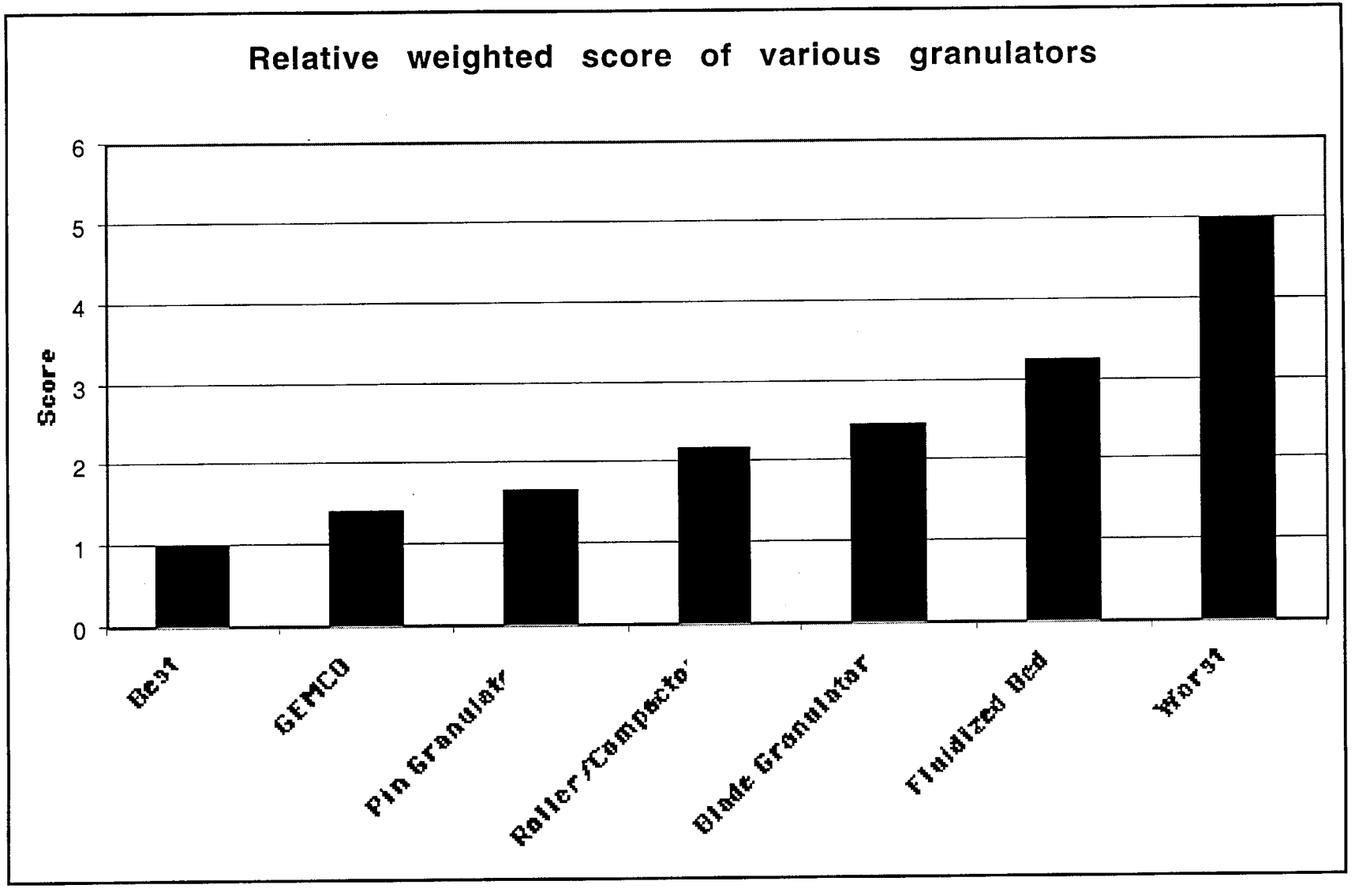
Relative weighted score of various granulators
Score
6
5
4
3
2
1
0
Best
GEMCO
Pin Granulator
Roller/Compactor
Blade Granulator
Fluidized Bed
Worst

Granulator Comparisons **Note: Red bold type indicates possible major impact**	**Roller/Compactor**		**Fluidized Bed**		**Blade Granulator**		**Pin Granulator**		**GEMCO**	
Criteria	**+**	**-**	**+**	**-**	**+**	**-**	**+**	**-**	**+**	**-**
Sintered puck characteristics 30%	Relatively less cracking experienced	Consistent, but somewhat coarser porosity in sintered pucks		More puck cracking observed	OK		OK		OK	
Granule characteristics 20%	Flows well Stable during storage	Fluffy attritor powder - will it transfer OK?? More observable dust in product	Easiest to handle / transfer	Granules trap gas / water? Somewhat dusty		Wide variations in granule size	Flows well		Flows well	
Process operations and maintenance 18%	Holdup reasonable and controllable	Relatively complex mechanically Relatively high maintenance possible Dusty Operation	No moving parts in glovebox	Filter servicing Filter holdup / leakage concerns Multiple control parameters Maintenance access concerns	Simple operation	Maintenance unknown	High throughput rate for size Small, glovebox friendly	Relatively high holdup in demo unit **Must control two streams, powder & moisture/binder**	Demonstrated with U which requires more moisture for granulation Relatively simple and easv to control	Make/break operations required for loading / unloading
Process upset 12%	No moisture additions Minimal in-process inventory in granulator	Wedge heel may occur and would require recovery Multiple coupled mechanical processes	Relatively good process control and flexibility	Concern about material getting past the primary filter	Minimal process variables	Product could get too wet with no good recovery mechanism		Rapid throughput makes process upset more likely - dusty or sticky product Recovery tricky	Simple process control	Excess moisture addition would result in clean-out problems. However, this situation is easily avoided.
Impact on preceeding/succeeding operations 10%	Lower relative ejection force from press [illegible]	Dusty during pressing [illegible]	Flows well	Pressing problems with dusting and puck layering Sintered puck quality [illegible]	OK		**Low dusting in press**		**Low dusting in press**	Requires make/break connections
Implementation 10%	Commercially available	Relatively Complex Equipment life not known [illegible]	Commercially available	Filter [illegible] changeout concerns Relatively complex exhaust system likely required	[illegible]	Significant design and development needed/new technology [illegible]	Plant size would be small Commercially available	Requires an auger feeder which somewhat complicates small and simple desian Equipment life unknown	Commercially available Relatively simple system	Requires make/break connection development and implementation [illegible]
Remarks/ Recommendations (Overall)	Further testing could upgrade to more advanced designs Only waterless option	Heavy reliance on mechanical compression for granulation		Filtering sub micron Pu not well demonstrated Additional testing required to make proper filter selection		[illegible] Highest cost/ schedule risk		Some holdup method may be required to set product quality before release from unit Run further tests to optimize performance and eliminate upset concerns Develop cleanout methods	Further explore vendor options for clean out & maintenance options Tumbling granulator has most operating experience, including w/uranium	Rotating bowl in GB - potential safety consideration